Environmental Monitors on Lobster Traps Phase VII: Validating Ocean Models

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Major accomplishments and milestones:

Considerable advances have been made towards the validation of local ocean models in the last few years. Given new utilities that allow investigators to remotely access a variety of web-served model output, it is now possible to examine these models without needing to bother the modeling teams that generate the output. These are powerful new tools that can be leveraged.

Because of the activity associated with this NEC-funded grant, I was invited to sit on a advisory panel that evaluates UMASSS Dartmouth's FVCOM model operations: the Northeast Coastal Ocean Forecast System. Much of the work that has been done and the tools that have been develop in this grant therefore have addressed the FVCOM model in particular. However, there are multiple models that simulate our coastal waters and these tools have been applied to these other models as well.

The validation of models has progressed along a few fronts associated with different data products. We compare the model output to eMOLT drifters, eMOLT bottom temperatures, and GoMOOS moored current observations. Examples of these comparisons are posted at http://www.nefsc.noaa.gov/epd/ocean/MainPage/circ/necofs_vs_eMOLT.html and are shown below in Figures 1, 2, and 3. While this website is a work in progress and should NOT be linked from any public site, it provides an up-to-date summary of our efforts to date. As of this writing, most of the code has been written to make the comparisons but a quantitative analysis of the models will not be complete for several months from now and the results should appear in the final report of this grant.

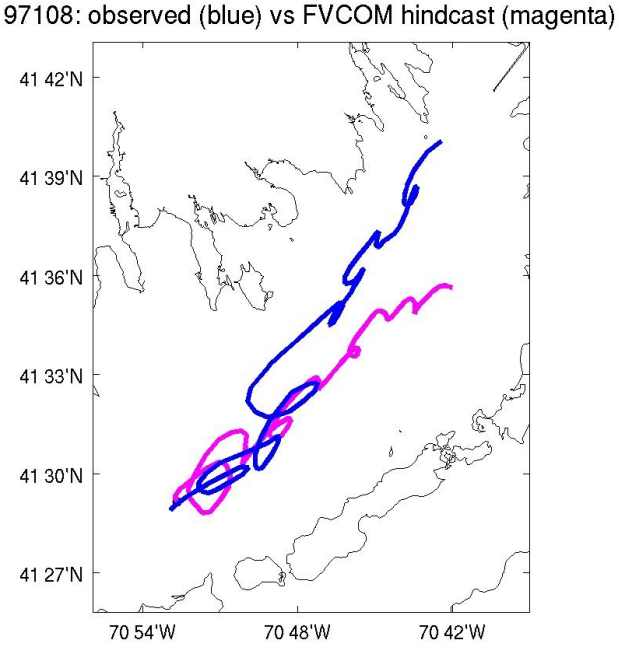

Figure 1. Example of comparing model drifter track vs observed. This case is for one drifter flowing up Buzzards Bay in July 2009 where the model captures the events but not the absolute values.

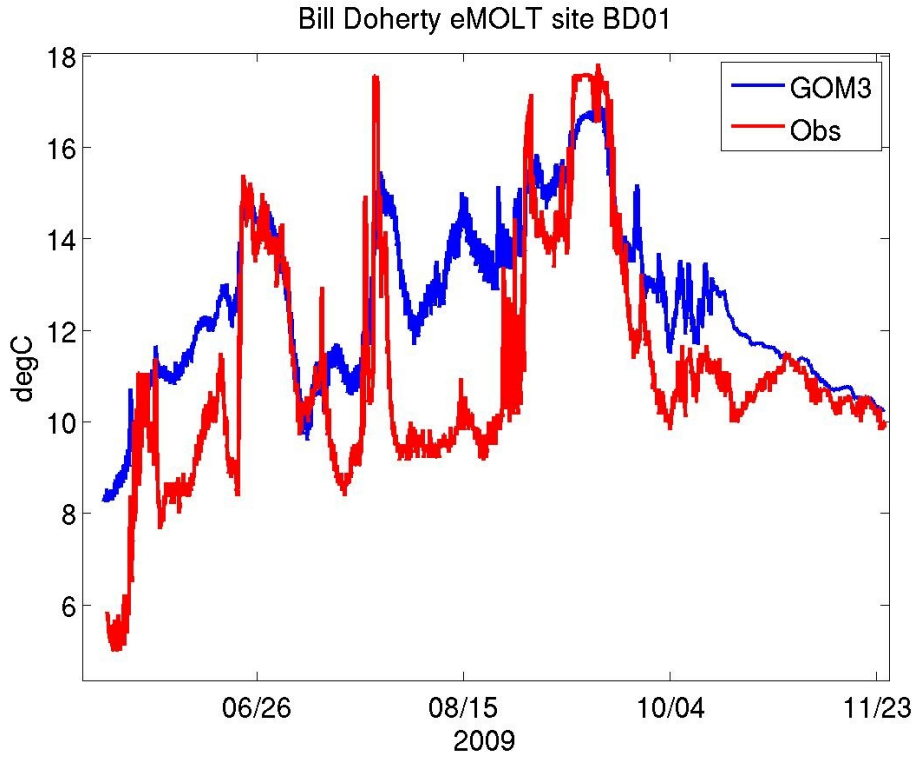

Figure 2. Example of comparing model temperatures to eMOLT bottom temperatures. This case is for Bill Doherty's site off Boston Harbor.

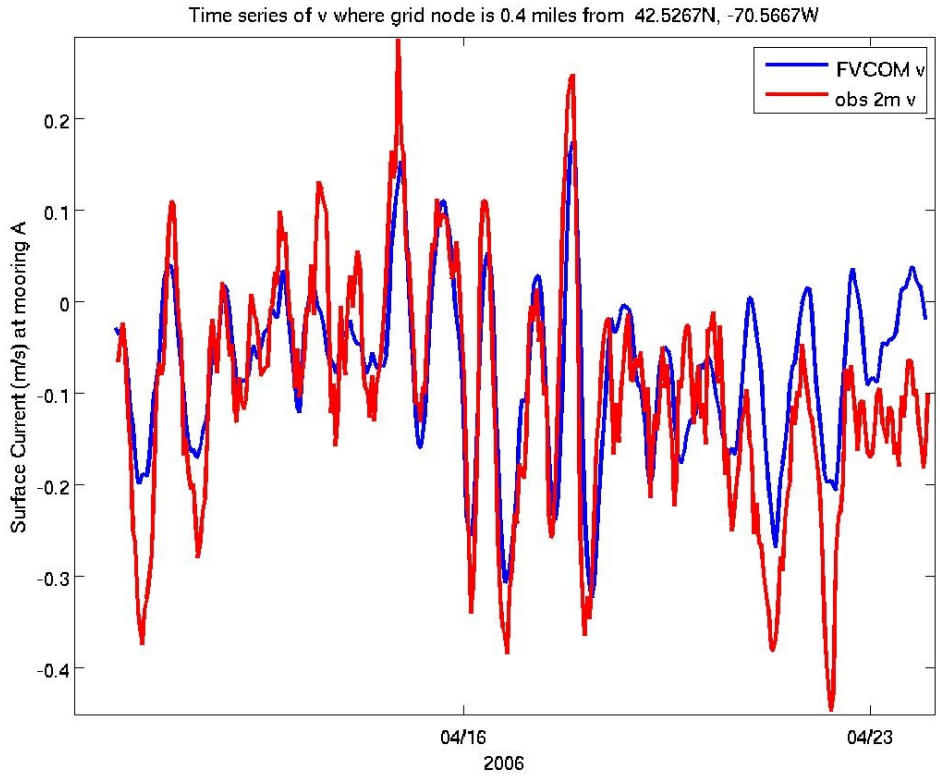

Figure 3. Example of comparing model to GoMOOS mooring time series of northward velocity. This case is for mooring "A" in April 2006 where the model does generally well.

Our drifter data is accessed by other groups for the purposes of validating their models. Both North Carolina State and UMASS Dartmouth have manuscripts underway that describe a model – data comparison.

Unexpected difficulties and project alterations:

At the beginning of our project year, in the spring of 2010, our attention was diverted to the Gulf of Mexico. Along with many of the oceanographers around the country, we were ask to address the oil spill. In May of 2010, we called upon some student laborers to help build and ship a few dozen drifters to various ports along the gulf coast. We made arrangements to distribute 25 units between our colleagues at a) Dauphin Island Sea Lab in Alabama, b) Univ. of South Florida at St Petersburg, and c) NOAA's AOML in Miami. We also arranged for deployments off two New England based ships, the R/V ENDEAVOR and R/V DELAWARE, that were headed to the gulf. The tracks of these drifters were posted in realtime and the data shared by multiple modeling groups for the purposes of assimilation and validation. The group at the University of South Florida, for example, used these drifters along with many others to understand the flow patterns throughout the gulf and posted results on their website at http://ocgweb.marine.usf.edu/DrifterMaps/OilDriftersNEFSC.php .

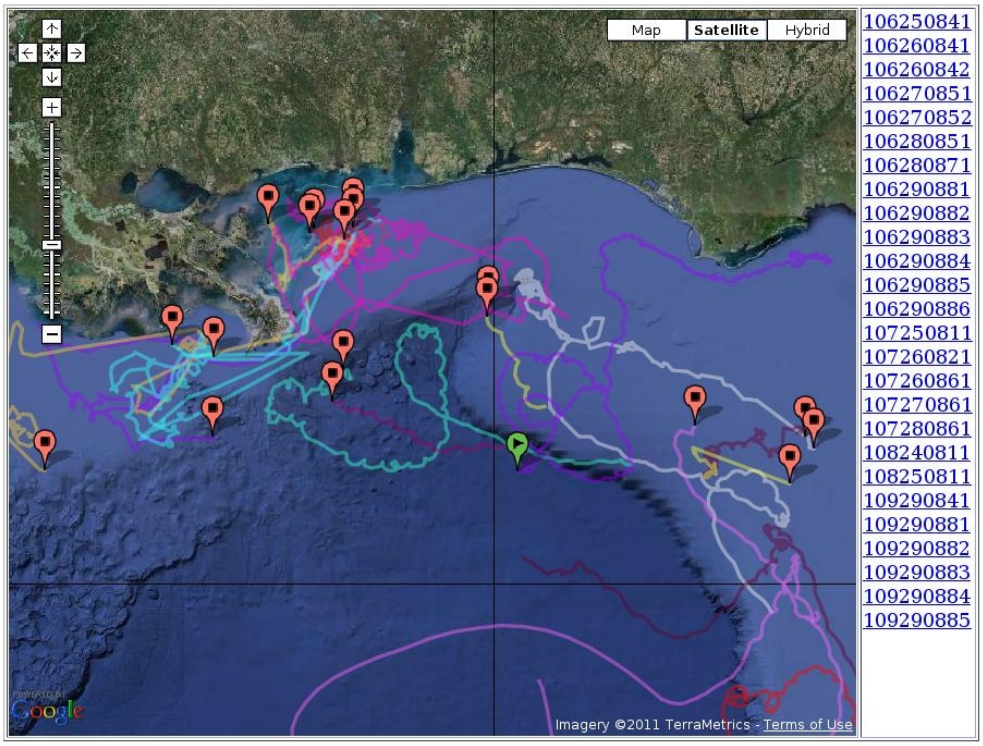

Figure 4. Tracks of drifters in the Gulf of Mexico. All of these drifters were built and subsequently tracks by New England school children.

Next Steps, tasks for the next 6 months:

Now that the tools have been developed (primarily MATLAB and PYTHON routines), we can begin to conduct more quantitative analysis of the models performance. When we deploy drifters early in 2011, we will be able to forecast the drifters path based on circulation model forecast. Particularly in the case of Mass Bay where there are now multiple models resolving some of the detailed complexity of this region, we will be able to simulate the drifter's projected path 2-3 days into the future. Given that we supplied both Quincy High School and UMASS Boston with several of our transmitters in the last few months, we expect to conduct more focussed studies within Boston Harbor and the waters immediately outside the harbor.

Given the Massachusetts Ocean Partnership funding the FVCOM modeling group, we hope to have a complete hindcast of our coastal waters from 1978 to present. As this product comes on-line, we will be better able to conduct a complete analysis of model vs observations. In the meantime, we continue to develop the tools and ways to properly evaluate the model's performance.

Impacts of the project to fishermen and science community

Hundreds of eMOLT-style drifters have been deployed over the last several years in support of the ECOHAB and GOMTOX programs to study the advection of Harmful Algal Blooms. In 2010, the GOMTOX-funded drifters revealed an unusual offshore veering of the coastal current near Casco Bay that helped explain the lack of toxic cells in the Mass Bay region that year. The realtime plots of these drifters are are often watched by shellfish managers as a index of the surface water transport towards or away from their shores. In years like 2005 where there was a series of northeasterly wind events, the drifters could be seen along the coast and advecting shoreward. It was a very different situation in 2010 (Figure 5). A manuscript by McGillicuddy et al is in preparation that provides the full story of the 2010 “wipeout” of HAB.

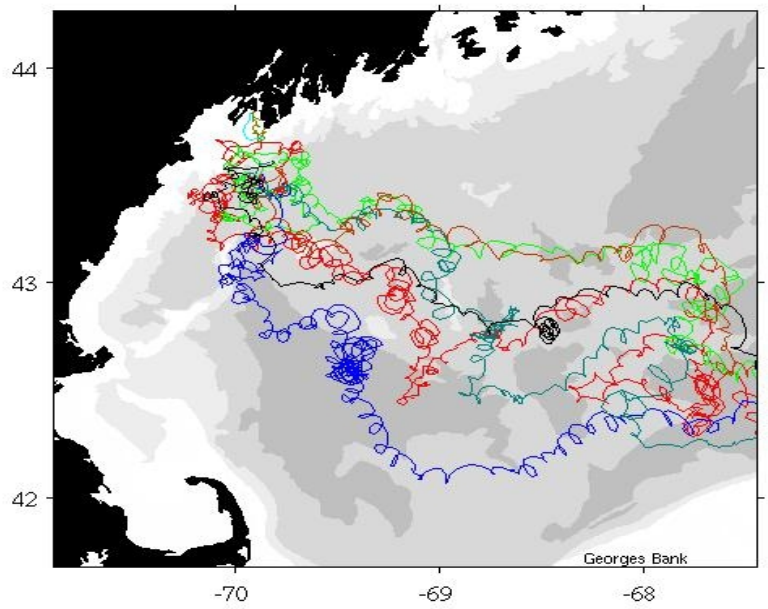

Figure 5. GOMTOX-funded drifters in 2010 tracking offshore from Casco Bay and therefore explaining the lack of toxic cells appearing in shellfish beds.

There are many other recent examples of why these models are useful. A few months ago, the question of why a sudden rise in the toxic Alexandrium cells in Nauset Inlet occurred in June 2009. We were ask to evaluate the circulation pattern of the coastal current just prior to that event to determine if there was an

influx of surface waters into the inlet. The combination of modeled and observed paths (Figure 6) depicts the real possibility.

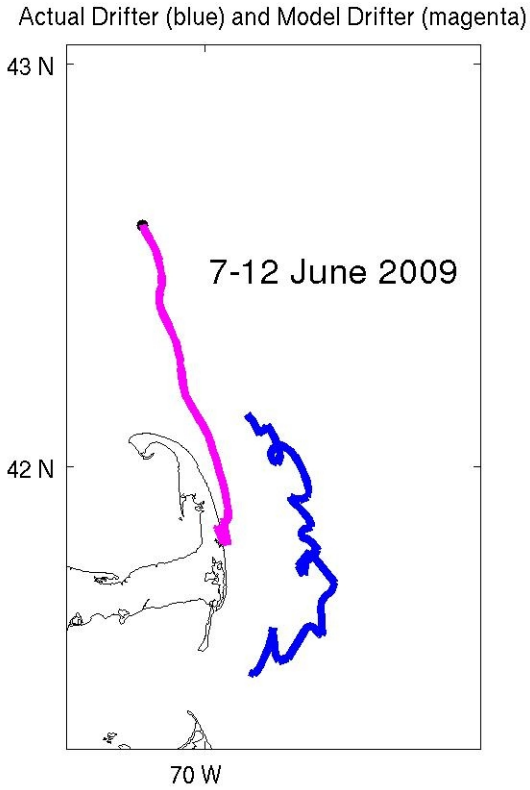

Figure 6. Trajectory of both actual and simulated drifter paths prior to the June 2009 toxic Alexandria outbreak in Nauset Inlet depicting the numerical results of a particle released in the model fields just east of Stellwagen Bank on June 7 (magenta).

This past year we were asked to simulate the path of a drifter that unfortunately lost its GPS transmissions but subsequently records tagged animals on the acoustic receiver that was attached to the drifter (Figure 7). The model in this case was the “simple” model as described by Manning et al 2009.

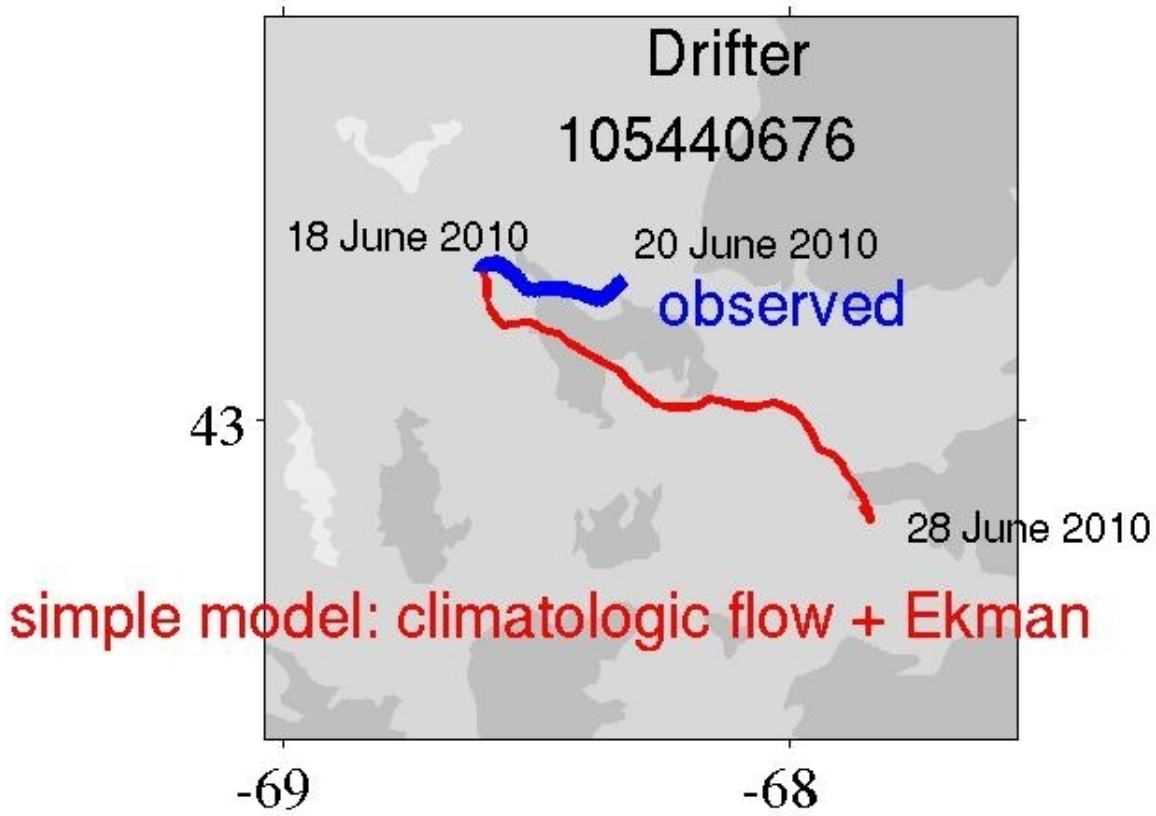

Figure 7. Trajectory of both actual (thick line) and modeled (thin red line) depicting the ESE-ward flow in late June 2010. The model is the result of moving a particle through empirically derived drifter climatology and adding a wind-driven Ekam component.

Finally, given this last phase of NEC funding, planning is underway for a full day eMOLT session at the Maine Fishermen Forum on 3 March 2011. Dozens of lobstermen are already registered for this event and will be treated to a series of talks including some by those most responsible for the FVCOM model, Changsheng Chen and Robert Beardsley. Lobstermen will hear first hand of the efforts underway to provide them with a real-time ocean forecast system.

References

Manning, J.P., D. McGillicuddy, N. Pettigrew, J. Churchill, L. Incze, 2009, Drifter Observations of Gulf of Maine Coastal Current, Continental Shelf Research. doi:10.1016/j.csr.2008.12.008.